Imnaha River Spring Chinook Population

The Imnaha River Chinook population (Figure 1) is part of the Snake River Spring/Summer Chinook ESU which has five major population groupings (MPGs), including: Lower Snake River, Grande Ronde / Imnaha, South Fork Salmon River, Middle Fork Salmon River, and the Upper Salmon River group. The ESU contains spring, spring-summer, and summer run Chinook. The Imnaha River population is a spring-summer run and is one of seven extant populations in the Grande Ronde / Imnaha MPG.

The ICTRT classified the Imnaha River population as an "intermediate" population (Table 1) based on historical habitat potential (ICTRT 2005). A Chinook population classified as intermediate has a mean minimum abundance threshold criteria of 750 naturally produced spawners with a sufficient intrinsic productivity (greater than 1.6 recruits per spawner at the abundance threshold) to achieve a 5% or less risk of extinction over a 100-year timeframe.

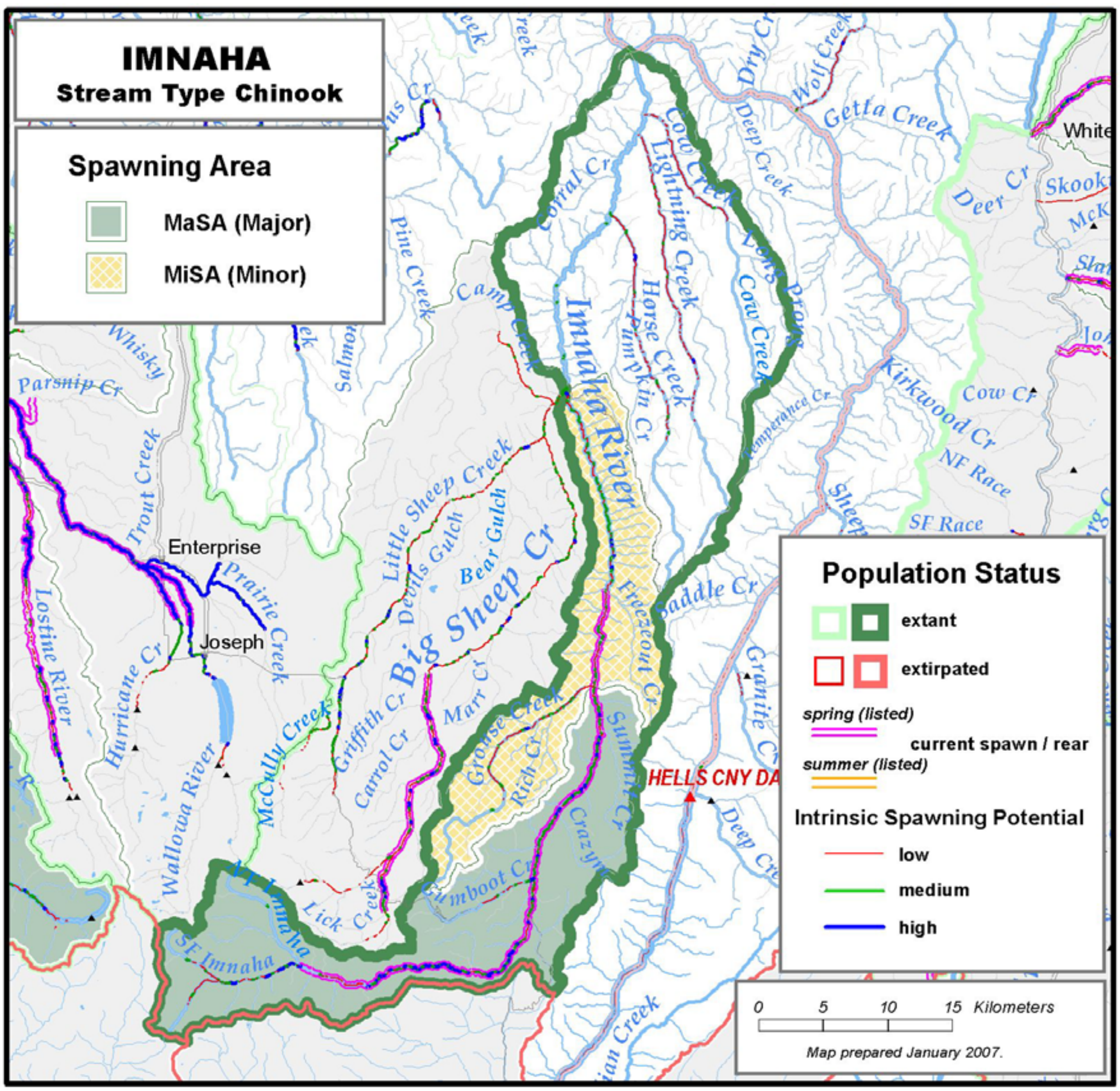

Figure 1. Imnaha River Spring Chinook Salmon population boundary and major (MaSA) and minor (MiSA) spawning areas.

Table 1. Imnaha River Spring Chinook population basin statistics and intrinsic potential analysis summary.

Drainage Area (km2)	1,318
Stream lengths km[a] (total)	522
Stream lengths km[a] (below natural barriers)	424
Branched stream area weighted by intrinsic potential (km2)	0.196
Branched stream area km2 (weighted and temp. limited)[b]	0.196
Total stream area weighted by intrinsic potential (km2)	0.428
Total stream area weighted by intrinsic potential (km2) temp limitedb	0.420
Size / Complexity category	Intermediate / "A" (Simple Linear)
Number of Major Spawning Areas	1
Number of Minor Spawning Areas	1

[a]All stream segments greater than or equal to 3.8m bankfull width were included
[b]Temperature limited areas were assessed by subtracting area where the mean weekly modeled water temperature was greater than 22°C.

Current Abundance and Productivity

Current (1949 to 2005) abundance (number of adult spawners in natural production areas) has ranged from 160 (1995) to 10,992 in 1955 (Figure 2). Abundance estimation methods have varied through time. Prior to 1985, spawner abundance estimates are based on redds observed during spawning ground surveys conducted annually since 1949. From 1985 to present, spawner abundance was estimated based on weir counts, mark-recapture estimates, and redd counts above and below the Imnaha weir with adjustments for pre-spawning mortality estimated from carcass recoveries.

Spawning ground surveys have been conducted once annually in index survey reaches from the Blue Hole to Mac's mine for most all years since 1949. Beginning in 1986 additional surveys beyond index were implemented. From 1986-1996, single pass surveys were conducted over the most of the known spawning habitat beginning at the Blue Hole and ending downstream at Grouse Creek. The habitat above the Blue Hole has been surveyed only periodically. Additional supplemental surveys were conducted in selected index reaches of the spawning habitat from 1987-1996, and beginning in 1997 all of the known spawning habitat was surveyed three times except above Blue Hole. For this analysis, observations of redds and the locations of surveys are those reported in Tranquilli et al. (2004), updated with annual summaries of spawning ground survey results (personal communications, P. Keniry and F. Monzyk, ODFW NE Fisheries Research Program, La Grande, OR), and cross referenced to Beamesderfer et al. (1997).

For years when only index surveys were conducted (1949-1985) and prior to initiation of mark-recapture estimates above the weir, we used the average proportion of redds observed in areas outside historical index surveys (from the 1986-2005 data) to estimate total redds at the index survey time. To account for spawning activity occurring later than the index survey dates, we calculated temporal adjustment factors for each year when supplemental surveys were conducted. For years when supplemental (1949-1986) surveys were not conducted, we assumed spawn timing was the same as the average of the later year-specific estimates. We estimated the total spawners for these years by multiplying total redds by an estimated 3.2 spawners per redd, observed on average since operation of the weir and mark-recapture estimates have been made (1985-2005).

From 1985 to present, total escapement was estimated based on weir counts of jacks and adults, mark-recapture estimates of adults, redd counts above the weir, and prespawning mortality estimates. Escapement above the weir was the sum of the known number of fish captured and subsequently passed above the weir and an estimated number of untrapped fish. The number of untrapped adults above the weir was determined from mark-recapture estimates of adults. Weir efficiency was determined from the ratio of trapped adults to the estimated total adults above the weir and applied to the number of trapped jacks to provide an estimate of total jacks above the weir. Escapement to the weir was the sum of the total trapped and estimated untrapped fish. Spawner escapement above the weir is the sum of fish released above the weir and untrapped fish adjusted downward for pre-spawn mortality. Pre-spawn survival was derived from female carcass information collected on spawning ground surveys and was the ratio of spawned-out females to total observed. Female carcasses containing greater than 50% of their eggs were considered pre-spawn mortalities. In the Imnaha River a significant number of fish spawn below the weir. We estimate the number of spawners below the weir as the total redds counted multiplied times the year specific fish per redd estimate derived from redd counts and fish abundance above the weir.

The estimate of spawners includes natural-origin and hatchery-origin fish. Prior to 1985, the hatchery fraction was 0%. From 1982 to present, the hatchery fraction of spawners was based on total spawner estimates and the proportion of hatchery origin fish determined by the presence of an adipose fin clip from fish trapped at the weir and recovered as carcasses on the spawning grounds.

Natural-origin fish are apportioned into brood year cohorts to estimate abundance of adult recruits. All Imnaha hatchery fish have been recognizably marked for identification. From 1949-1981, age structure of natural origin spawners on spawning grounds was determined from carcass recoveries when sufficient sample sizes were available (n>20). From 1982-2005 age structure of natural origin spawners was determined by scale analysis and from fish sampled at the weir, collected for broodstock, and recovered below the weir. If insufficient sample sizes were available, average run-year age structure for all years was used.

Recent year natural spawners include returns originating from naturally spawning parents, and hatchery fish released into the Imnaha River from Lookingglass Fish Hatchery. Hatchery fish returning to the Imnaha River are of Imnaha River hatchery stock origin. The hatchery program began with the 1982 brood year and the first hatchery fish returned in 1985. Natural-origin spawners have comprised an average of 81% of total spawners since 1949, while the most recent 10-year average is 35% (Table 2).

Abundance in recent years has been highly variable, the most recent 10-year geomean number of natural-origin spawners was 395 (Table 2). During the period 1981-2000, returns per spawner for Chinook in Imnaha River ranged from 0.15 (1993) to 4.38 (1997). The most recent 20 year (1978-1997) SAR adjusted and delimited (at 75% (503 spawners) of the 750 abundance threshold) geometric mean of returns per spawner was 0.84 (Table 2).

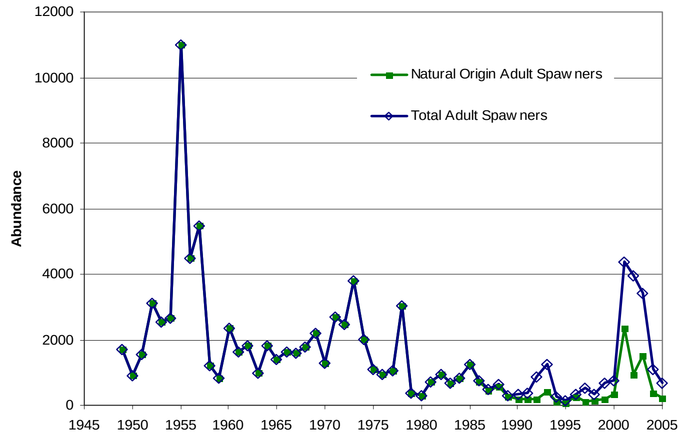

Figure 2. Imnaha River Spring Chinook Salmon population spawner abundance estimates (1949-2005).

Table 2. Imnaha River Spring Chinook Salmon population abundance and productivity estimates.

10-year geomean natural abundance	395
20-year return/spawner productivity	0.60
20-year return/spawner productivity, SAR adj. and delimited[a]	0.80
20-year Bev-Holt fit productivity, SAR adjusted	1.42
20-year Lambda productivity estimate	1.05
Average proportion natural origin spawners (recent 10 years)	0.35
Reproductive success adj. for hatchery origin spawners	n/a

[a]Delimited productivity excludes any spawner/return pair where the spawner number exceeds the median parent escapement for the data series. This approach attempts to remove density dependence effects that may influence the productivity estimate.

Comparison to the Viability Curve

- Abundance: 10-yr geomean natural origin spawners
- Productivity: 20-yr geomean R/S (adjusted for marine survival and delimited at 663 spawners)
- Curve: Hockey-Stick curve
- Conclusion: The Imnaha River population is at **HIGH** risk based on current abundance and productivity. The point estimate resides below the 25% risk curve (Figure 3).

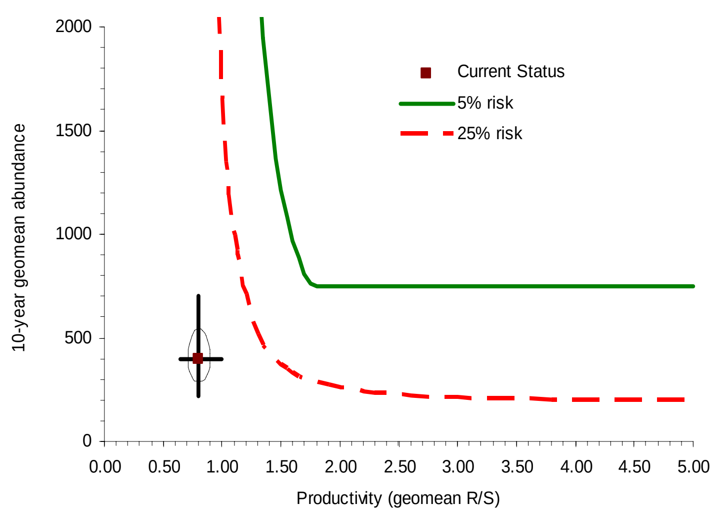

Figure 3. Imnaha River Spring Chinook current estimate of abundance and productivity compared to the viability curve for this ESU. The point estimate includes a 1 SE ellipse and 95% CI (1.81 X SE abundance line, and 1.83 X SE productivity line).

Spatial Structure and Diversity

The ICTRT has identified one major spawning area (MaSA) and one minor spawning area (MiSA) within the Imnaha River Spring Chinook population (Figure 4). No modeled temperature limitations exist within the MaSA/MiSAs for this population. Current spawning distribution is similar to historic with the primary spawning area from the Blue Hole to Crazyman Creek in the mainstem of the Imnaha River. In addition, spawning occurs to a minor degree above the Blue Hole and between Crazyman Creek and Grouse Creek. Spawners in recent years consist of natural-origin and hatchery-origin fish. Hatchery supplementation has been ongoing in the Imnaha River with Imnaha River stock since the mid 1980's. Hatchery fish have comprised a significant fraction of natural spawners since 1985. Hatchery strays from other Snake River hatchery programs or outside Snake Basin programs have rarely been observed in the Imnaha River.

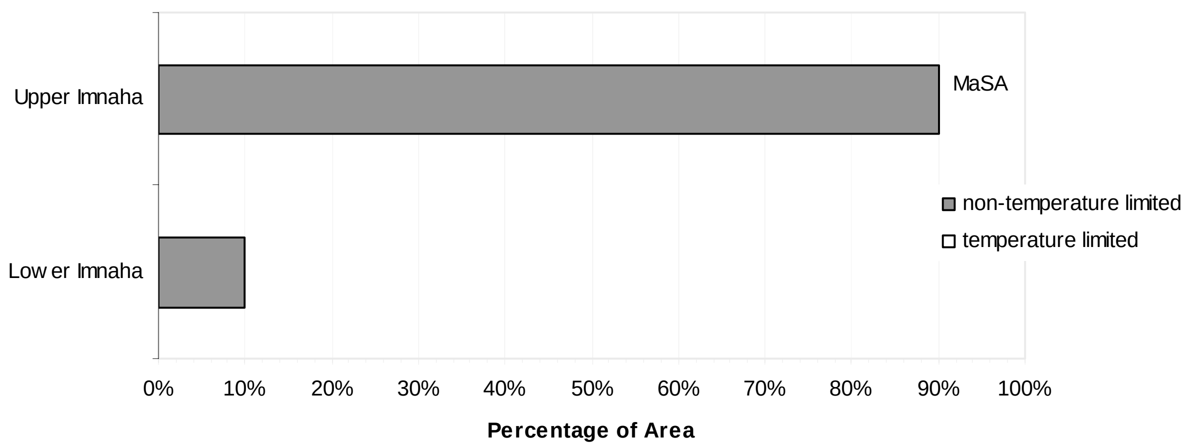

Figure 4. Imnaha River Spring Chinook Salmon population distribution of intrinsic potential habitat across major and minor spawning areas.

Factors and Metrics

<u>A.1.a. Number and spatial arrangement of spawning areas.</u>

The Imnaha River Chinook population has one MaSA and one MiSA. The total intrinsic weighted area equates to the minimum required for two MaSAs. Based on complete area spawning ground surveys conducted since 1986 both the MaSA and MiSA are currently occupied. Because the Imnaha River population is an "A" type with linear distribution, it rates at **moderate risk** for this metric.

A.l.b. Spatial extent or range of population.

The current spawner distribution mirrors the historical distribution with the one MaSA and one MiSA occupied (Figure 5). The current spatial extent and range criteria for the Imnaha River population is rated at **low risk**.

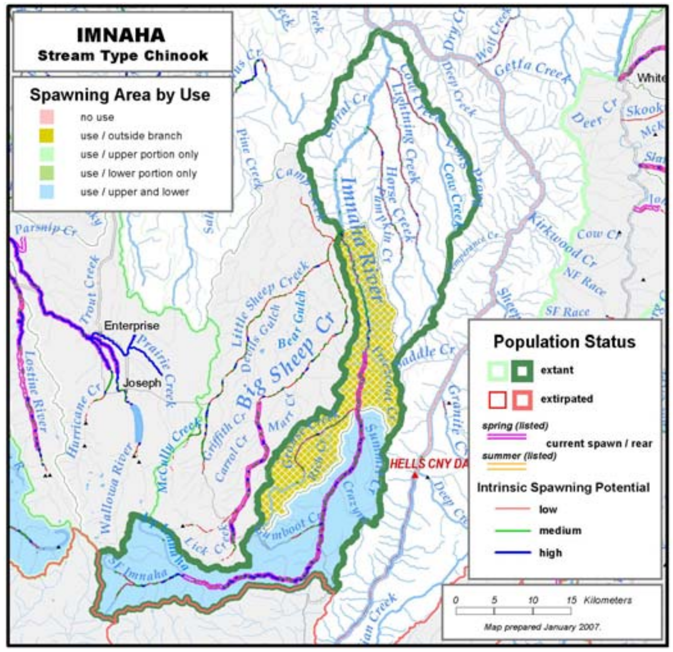

Figure 5. Imnaha River Spring Chinook Salmon population current spawning distribution and spawning area occupancy designations.

A.1.c. Increase or decrease in gaps or continuities between spawning areas.

There have been no increases in gaps between spawning areas or any loss of occupancy in any MaSAs. Connectivity between spawning areas is unchanged from historical conditions. The Imnaha River population rates at **low risk** for gaps.

B.1.a. Major life history strategies.

Limited information exists to compare historic life history patterns with current pathways. However, studies conducted in the 1960s do provide some information to assess current and past juvenile movement pathways. In addition we use habitat information to infer changes in life history pathways. There are two primary juvenile life history strategies that were exhibited in the past and are currently utilized. Fish either rear from emergent fry to smolt in the spawning area or they redistribute downstream in the fall, including movement from the Imnaha River into the Snake River. There does not appear to be any loss in life history pathways for juvenile life stages in the Imnaha River. Habitat conditions have not been altered to the extent that major life history pathways, such as adult migration and spawn timing, have been significantly changed. All historic pathways are likely present. We have rated this population at **low risk** for this metric.

B.1.b. Phenotypic variation.

Data are not available to directly assess changes in phenotypic variation. We use habitat changes to infer potential changes in phenotypic traits. We have rated the Imnaha River population at **low risk** because seaward migration timing through the mainstem Snake and Columbia rivers has likely been altered due to flow and temperature changes, although we are uncertain of the degree of change.

B.1.c. Genetic variation.

The Imnaha River population has been rated at **moderate risk** for genetic variation. The hatchery fish are not significantly diverged from natural-origin fish. There appears much lower interannual variation within this population than is seen for some other populations. The Imnaha natural fish are not significantly different from many Snake River hatchery samples. However, introgression from other Snake River hatchery stocks does not explain this similarity. Extensive sampling of hatchery fish in the Imnaha Basin since the mid-1980s indicates that few if any stray hatchery fish are present in this population.

B.2.a. Spawner composition.

(1) *Out-of-ESU spawners*. Over the past three generations (1991-2005), we have recovered a total of five marked out-of-ESU stray hatchery fish. Two originated from Rapid River Hatchery in Idaho, two from Lookingglass Fish Hatchery, and one from a release in Young's Bay. The mean percentage of out-of-ESU strays over the past three generations was 0.2%. We have rated this metric as **low risk**.

(2) *Out-of-MPG spawners from within the ESU*. There have been no out-of-MPG with ESU strays recovered in the Imnaha River. We have rated this metric as **very low risk**.

(3) *Out of population within MPG spawners*. Over the past three generations we have recovered a total of four out-of-population within MPG strays. Two strays were Lostine hatchery stock and two were Catherine Creek hatchery stock. The mean percent out-of-population strays over the past three generations was less than 0.1%. We have rated this metric as **low risk**.

(4) *Within-population hatchery spawners.* The Imnaha hatchery program has been operating since 1982. The program utilized wild Imnaha Chinook initially and now uses both hatchery- and natural-origin fish for broodstock. Hatchery fish have comprised a significant proportion of natural spawners. Over the past three generations hatchery fish have comprised 51.6% of the natural spawners. We have characterized this program as not using "best management practices" because broodstock collection is selective for later returning fish and natural-origin fish have averaged only a small fraction of the hatchery broodstock spawned annually. We have rated this metric as **high risk**.

The overall rating for spawner composition is **high risk**.

B.3.a. Distribution of population across habitat types.

The intrinsic distribution of the Imnaha River population encompassed three ecoregions (Figure 6) that accounted for greater than 10% of the distribution. Current distribution is nearly identical to historic and there has not been any substantial change in ecoregion distribution (Table 3). We have rated this metric as **low risk**.

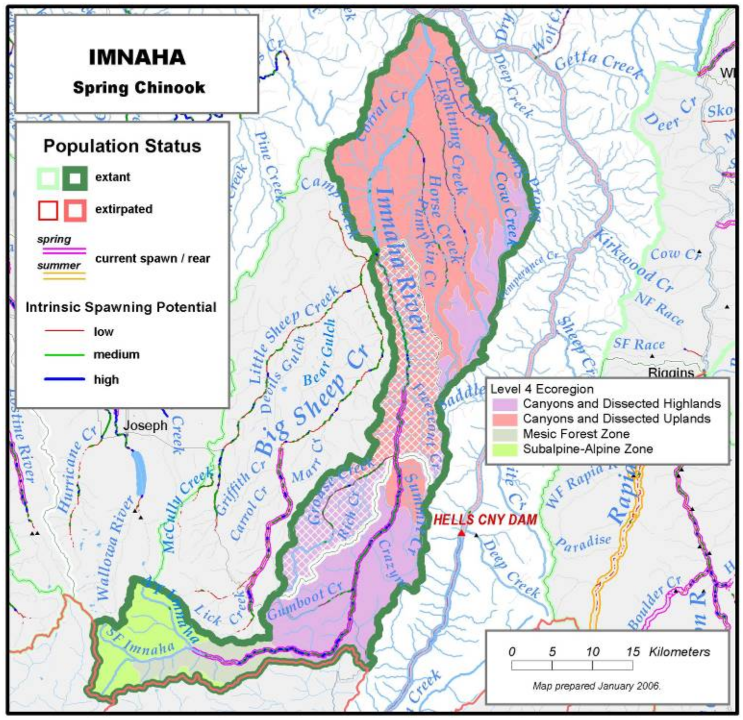

Figure 6. Imnaha River Spring Chinook Salmon population spawning distribution across EPA level 4 ecoregions.

Table 3. Imnaha River Spring Chinook Salmon population proportion of current spawning areas across EPA level 4 ecoregions.

Ecoregion	% of historical branch spawning area in this ecoregion (non-temperature limited)	% of historical branch spawning area in this ecoregion (temperature limited)	% of currently occupied spawning area in this ecoregion (non-temperature limited)
Canyons and Dissected Highlands	60.8	60.8	64.5
Canyons and Dissected Uplands	22.9	22.9	21.6
Mesic Forest Zone	16.4	16.4	16.8

B.4.a. Selective change in natural processes or selective impacts.

Hydropower system: The hydropower system and associated reservoirs likely pose selective mortality on both adult upstream migrants and downstream migrating smolts. Smolts are affected by altered migration timing, duration, timing-survival relationships, and altered ocean entrance time. We do not have quantitative data to assess if the mortality is selective on 25% or more of the affected individuals. We hypothesize that the mortality is not 25% or greater consistently for any life stage-component combination. However, we have rated this metric as **low risk**.

Harvest: Current harvest regulations are very restrictive and allow for only a small proportion (5-10%) of Snake River spring/summer Chinook to be harvested annually. The methods of harvest are generally non-selective for adult sized fish. We have rated this metric as **low risk**.

Hatcheries: Hatchery production has been ongoing in the Imnaha River population since 1982 when initial broodstock were collected under the LSRCP program. In many years installation of the weir occurs after a significant component of the run has passed the weir site. ODFW has estimated that on average 38% of the run passes the weir site prior to weir installation. Late weir installation results in selective removal of fish in the late part of the run, selective artificial enhancement of the later part of the run, and hatchery fish with later run timing than natural fish. Due to the combination of these selective factors we have rated this metric as **moderate risk**.

Habitat: There does not appear to be any within basin habitat change which would pose significant selective mortality on adult or juvenile life stages. We have rated the metric as **low risk**.

The overall rating for selective changes is **moderate risk**.

Spatial Structure and Diversity Summary

The combined integrated Spatial Structure/Diversity rating is moderate risk for the Imnaha River population (Table 4). The rating for Goal A “allowing natural rates and levels of spatially mediated processes” was low risk. The current spawning distribution mimics the intrinsic distribution. The population is distributed throughout a large reach of the mainstem Imnaha River. Good continuity exists in the distribution without any gaps.

The rating for Goal B “maintaining natural levels of variation” was moderate risk. This Goal B rating was primarily driven by three metrics: genetic variation, spawner composition, and hatchery selective change. The genetic variation rating of moderate was a result of low within population interannual variation. The spawner composition rating of high risk is a result of a long-term high natural spawner hatchery fraction of Imnaha hatchery fish (Table 5). Hatchery selective change was rated as moderate risk due to the selective nature of broodstock collection.

Table 4. Imnaha River Spring Chinook Salmon population spatial structure and diversity risk rating summary.

Metric	Risk Assessment Scores				
	Metric	Factor	Mechanism	Goal	Population
A.1.a	M (0)	M (0)	Mean (0.67) Low Risk	Low Risk	Moderate Risk
A.1.b	L (1)	L (1)			
A.1.c	L (1)	L (1)			
B.1.a	L (1)	L (1)	Moderate (0)	Mean = (0) Moderate Risk	
B.1.b	L (1)	L (1)			
B.1.c	M (0)	M (0)			
B.2.a(1)	L (1)	High (-1)	High (-1)		
B.2.a(2)	VL (2)				
B.2.a(3)	L (1)				
B.2.a(4)	H (-1)				
B.3.a	L (1)	L (1)	L (1)		
B.4.a	M (0)	M (0)	M (0)		

Overall Viability Rating:

The overall viability rating for the Imnaha River spring-summer Chinook population does not meet viability and is considered high risk (Figure 7). The 10-year geomean natural-origin abundance is 395 which is only 52.7% of the minimum abundance threshold of 750. The point estimate of productivity (0.84, Table 6) is in the high risk zone and well below the viability target of 1.6 recruits per spawner. The spatial structure/diversity rating is moderate risk due to genetics and hatchery influence on spawner composition and selective change metrics.

		Spatial Structure/Diversity Risk			
		Very Low	**Low**	**Moderate**	**High**
Abundance/ Productivity Risk	**Very Low** (<1%)	**HV**	**HV**	**V**	M*
	Low (1-5%)	**V**	**V**	**V**	M*
	Moderate (6 – 25%)	M*	M*	M*	
	High (>25%)			**Imnaha**	

Figure 7. Imnaha River Spring Chinook Salmon population risk ratings integrated across the four viable salmonid population (VSP) metrics. *Viability Key: HV – Highly Viable; V – Viable; M – Candidate for Maintained; Shaded cells-- not meeting viability criteria (darkest cells are at greatest risk).*

Imnaha River Spring Chinook – Data Summary

Data type: Redd count expansions
SAR: Averaged Williams/CSS series

Table 5. Imnaha River Spring Chinook Salmon population abundance and productivity data used for curve fits and R/S analysis. Bolded values were used in estimating the current productivity (Table 6).

Brood Year	Adult Spnr	%Wild	Nat. Adults	Nat. Rtns	R/S	Rel. SAR	Adj. Rtns	Adj. R/S
1981	728	1.00	728	1263	1.73	0.63	794	1.09
1982	949	1.00	949	627	0.66	0.51	320	0.34
1983	699	1.00	699	818	1.17	0.58	471	0.67
1984	831	1.00	831	219	0.26	1.65	361	0.43
1985	1239	0.92	1239	197	0.16	1.57	310	0.25
1986	757	0.94	723	208	0.27	1.41	294	0.39
1987	**488**	**0.90**	**472**	**178**	**0.36**	**1.83**	**324**	**0.66**
1988	**634**	**0.85**	**576**	**427**	**0.67**	**0.75**	**319**	**0.50**
1989	**294**	**0.73**	**253**	**178**	**0.60**	**1.79**	**319**	**1.08**
1990	**352**	**0.51**	**188**	**61**	**0.17**	**4.65**	**286**	**0.81**
1991	**379**	**0.31**	**183**	**108**	**0.28**	**3.01**	**324**	**0.86**
1992	884	0.21	191	261	0.30	1.65	432	0.49
1993	1259	0.34	426	190	0.15	1.61	306	0.24
1994	**251**	**0.45**	**116**	**101**	**0.40**	**1.04**	**105**	**0.42**
1995	**160**	**0.56**	**86**	**187**	**1.17**	**0.60**	**112**	**0.70**
1996	**339**	**0.66**	**255**	**583**	**1.72**	**0.54**	**317**	**0.93**
1997	**551**	**0.23**	**124**	**2412**	**4.38**	**0.30**	**713**	**1.30**
1998	**330**	**0.40**	**156**	**1304**	**3.95**	**0.30**	**387**	**1.17**
1999	691	0.21	188	889	1.29	0.65	576	0.83
2000	775	0.38	337	360	0.46	1.00	360	0.46
2001	4379	0.48	2357					
2002	3965	0.24	951					
2003	3438	0.34	1520					
2004	1105	0.27	367					
2005	699	0.32	236					

Table 6. Imnaha River Spring Chinook Salmon population geometric mean abundance and productivity estimates (values used for current productivity and abundance are shown in boxes).

	R/S measures				Lambda measures		Abundance
	Not adjusted		SAR adjusted		Not adjusted		Nat. origin
delimited	median	75% threshold	median	75% threshold	1989-2000	1981-2000	geomean
Point Est.	0.80	0.81	$\boxed{0.80}$	$\boxed{0.84}$	1.13	1.05	$\boxed{395}$
Std. Err.	0.35	0.39	0.12	0.12	0.35	0.26	0.32
count	10	9	10	9	12	20	10

Table 7. Imnaha River Spring Chinook Salmon population stock-recruitment curve fit parameter estimates. Biologically unrealistic or highly uncertain values are highlighted in grey.

	Not adjusted for SAR							Adjusted for SAR						
SR Model	a	SE	b	SE	adj. var	auto	AICc	a	SE	b	SE	adj. var	auto	AICc
Rand-Walk	0.60	0.13	n/a	n/a	0.52	0.68	60.7	0.61	0.07	n/a	n/a	0.20	0.39	32.9
Const. Rec	333	70	n/a	n/a	n/a	n/a	59.2	336	35	n/a	n/a	n/a	n/a	31.4
Bev-Holt	1.64	1.55	557	343	0.44	0.69	60.6	1.42	0.47	626	171	0.12	0.36	24.7
Hock-Stk	0.76	0.15	551	0	0.39	0.70	59.2	0.80	0.09	519	76	0.09	0.33	18.7
Ricker	1.43	0.65	0.00136	0.00065	0.42	0.68	59.6	1.26	0.22	0.00115	0.00025	0.11	0.31	21.5

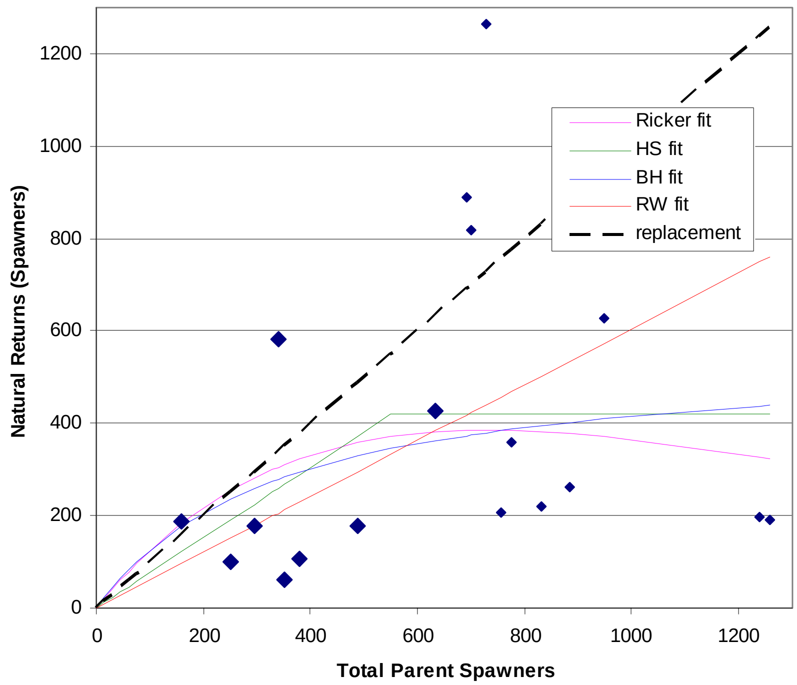

Figure 8. Imnaha River Spring Chinook Salmon population stock recruitment curves. Bold points were used in estimating the current productivity. Data were not adjusted for marine survival.

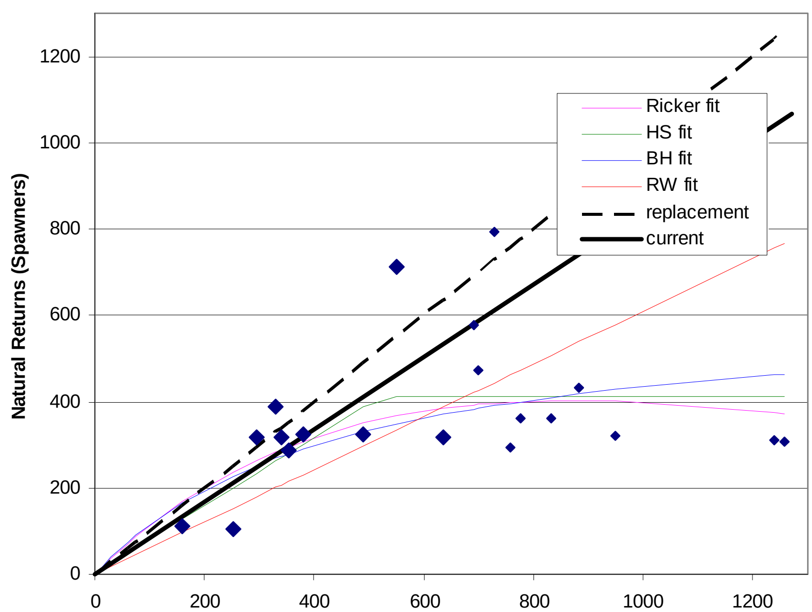

Figure 9. Imnaha River Spring Chinook Salmon population stock recruitment curves. Bold points were used in estimating the current productivity. Data were adjusted for marine survival.